E – 47

Development Of Learning Mathematics To Train Students' Metacognitive Ability

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Abstract

The student ability in metacognition is one of the important things after a high school level education, which has been formally specified in 2013 curriculum. On implementation we are dealing with the fact that the teachers at the high school level generally do not understand of metacognition yet, but on the other hand they shall teach the students to have metacognition ability. For this reason, the teachers need to get an adequate understanding of metacognition and how to train the students. The procedures in this study are: (1) the initial investigation, (2) design, (3) realization/construction, (4) testing, evaluation, and revisions, and (5) the implementation. The implementation of the research is divided into two main activities, namely (a) the production which include phase 1, 2, and 3 were implemented in the first year, and (b) testing and implementation, include stages 4 and 5 hold on second year. The results of the research that has been achieved is the draft metacognitive learning model applied in mathematics courses. The result of this development is still in testing phase in order to obtain appropriate metacognitive learning model, especially for math. It can be concluded that metacognitive learning model can be developed by placing the metacognitive questioning as an important factor to develop and train the students' metacognition ability.

Keywords: metacognitive learning, learning mathematics

BACKGROUND

There are many factors that determine the amount of benefits to be gained from the study of mathematics, one of which is the learning process quality. Learning process quality relates to the ability of the teacher to manage the learning so that students can exert its ability to absorb the lessons and be able to develop the knowledge to solve the problem.

The teacher in the learning process so far has made many attempts to obtain good results, but many of these efforts are still focused only on the curriculum and teaching methods, not related to the needs and participation of students (MuijsandReynolds, 2008:12). This resulted the learning is still likely to be directed to solve the problem according to the teacher's perspectives, and the student has not be a subject that will meet the learning needs or solve his problems. This situation makes the students tend to be in the passive position of receiving a lesson.

Active learning is only possible when students are involved from the beginning not only physically, but also his mind. The involvement of the mind can be accomplished when the learning process can raise students' awareness of the knowledge they already have and setting cognition to acquire new knowledge.

Awareness and regulation of knowledge in this regard relates to the ability of students to develop a variety of ways that may be taken in learning or problem solving. In order for this ability can be owned and developed, required teacher support, such as giving an opportunity to the students to resolve problems in its own way, as well as helping students to recognize and regulate their own thinking processes when learning or solving mathematical problems. The process to aware and regulate the students' own thinking, known as metacognition (GartmanandFreiberg, 1993).

The importance of the metakognition ability in helping students mastery the subject matter as well as to continue studying at the higher levels has received strong support from the government. According to the 2013 curriculum, competency standards (SKL) SMA/ MA is mastery the facts, concepts, procedures, and metacognitive. The existence of metacognition as one component of SKL is one of the important and interesting things. On the one hand, metacognitive abilities is important forevery graduate of high school, buton the other hand metacognition is still not understood yet by most teachers in Indonesia. Teachers' low understanding of the metacognition would be an obstacle to the achievement of competence contained in the SKL. This paper is offer as one of the solutions for improving the quality of learning, especially the learning of mathematics through the development of a mathematical learning model to train students' metacognition ability.

Metacognition is simply defineds thinking about what people think. Metacognition is generally associated with two-dimensional thinking, (1) self-awareness of cognition, an awarenessofone's own thinking, and (2) self-regulation of cognition, is ability to use awareness to adjust thinking process (Bruning, Schrawand Ronning, 1995). Both dimensions of metacognition are inter dependent on each other.

According to Brown (Gama, 2004) both dimensions of metacognition are difference. Self-awareness of cognition is influenced by age, so the ability of a person related to this dimension will depend on the age and experience of learning. Self-regulation of cognition are relatively not depends on age but depends on the situation and tasks, so as to increase it required the creation of a conducive learning atmosphere as well as the corresponding task.

When students learn or solve math problems, there will be a dynamic thinking process which involve awareness and regulation of knowledge. The Ability is required to understand the problem, create a solution plan, implement the plan solving, to look back on the process and results of solving. Anggo research results (2011) show that when solving a contextual mathematical problem, student involves more metacognition activity than when solving the formal mathematics problems.

DEVELOPMENT OF A LEARNING MODEL

The learning model is a plan or pattern that can be used to design learning in the classroom or face-to-face setting tutorial and to determine the learning material (Joyce, Weil, and Showers, 1992;4). According to Arends (2009; 259) a learning model includes the overall learning approach that has some attributes that the existence of a coherent theoretical basis or a view point on what should be learned and how they learn, as well as the recommendations of teaching behaviors and class structure needed to achieve a variety of different types of learning. Base on these opinions can be said that a learning model covers the whole course of learning settings supported by appropriate learning tools to achieveits intended purpose.

Joyce, Weiland Shower (1992,14) suggests four essential elements as a description of a learning model, namely (1) syntax, which is a sequence of learning activities, (2) the social system, the role of teachers and students as well as the rules required, (3) the principles of reaction, to give an idea to the teachers on how to view orrespond to the students, and (4) support system, the conditions required by the model.

Inrelation to the development of learning model, Plomp (1997) shows a general modeling designing education (including learning). This model consists of five stages, namely: (a).Initial assessment phase, which are defining the problem, and context analysis. (b). Design phase, the design resolution of identified problems. (c). realization/construction phase, which makes the prototype based on the design of the main initial design. (d). Testing, evaluation, and revision, aiming to consider the quality of the design will be developed. Evaluation includes a process to collect and analyze in formation systematically. (e). Implementation phase, the solution has been obtained after evaluation, then it can be implemented in real situations.

To complement the above development phase, then we applied three aspects of quality of education by Nieveen (1999), the validity, practicality, and effectiveness. The development of learning model includes syntax, social systems, reaction principles, and support systems.

LEARNING MATHEMATICS

Learning is an attempt to make students learn. That effort is the activity of the teacher giving aid, facilitate, creation of conditions that enable students to reach/have the ability, skills, and attitudes. Learning can not be separated from the subject that learned(students), teaching materials (math) and subject teached(teacher). Students as learning subjects has perception, attention, comprehension, reasoning, motivation, culture, and the ability to adapt to environment.

Learning mathematics is undertaken to equip learners logical thinking ability, analytical, systematic, critical, and creative, as well as shaping independence and ability to cooperate. Ability is required so that learners can acquire, manage, and utilize their knowledge to solve problems or for further learning activities. From this understanding it is clear that learning mathematics is not only concerned to implement the cognitive aspects, but also attitudes and a skills that must be owned.

When learning mathematics based only on the delivery of course material, then actually the learning has lost its way. Teachers must realize that he was dealing with a human being from educational needs. For this reason, teachers are required to be present significantly mathematics, through the relationship between the subject matter presented with an object, phenomenon, or behavior, which has been well recognized by students.

METACOGNITION

Metacognition in simply is defined as thinking about thinking or cognition about cognition (Gama, 2004). There are several definitions of metacognition are developing in the field of cognitive psychology, including Flavell defined metacognition as the ability to understand and monitor the self thinking and the assumptions and implications of one's activity (Lee andBaylor, 2006). This opinion emphasizes metacognition as the ability to understand and monitor the activities of thinking, so that the process of metacognition each person will vary according to ability.

Meanwhile, Brown defines metacognition as an awareness of the activities of self-cognition, the methods used to regulate the process of cognition and amastery of how to direct, plan, and monitor cognitive activity. Brown's opinion emphasizes metacognition as the awareness of the activity of cognition. Metacognition relates to

how a person realizes his thinking process, which is manifested in how to organize and manage the activity of thinking.

In this paper metacognition is defined as the awareness and and self-regulation of cognition. Thus, there are two important sides of metacognition, namely (1) awareness about cognition, and (2) control or regulation of cognition processes. Awareness about cognition includes assessment of what is known and not known, and the methods used to regulate the process of cognition. While control or regulation of cognition include directing, planning and monitoring the activity of cognition.

Several researchers have shown that metacognition plays an important role in solving the problem as well as the acquisition and application of skills learned in the various fields of discovery (Panaoura and Philippou, 2005). Giving scaffolding metacognitive to the students when solving problems can improve student ability to understand mathematical concepts (Awi, 2011). Students who are able to use the metacognitive ability also has a better mathematical ability (Nugrahaningsih, 2010). Students who carry out activities of metacognitionin problem solving also have good mathematical skills (Anggo, 2011).

METACOGNITIVE LEARNING

As mentioned in the previous section that the development of regulation of cognition is not depend age but is more depend on situation and the task. This means that a person can not acquire or improve regulation of cognitive ability without going through a process of preparation for it. This is where the role of the teacher is required to prepare and generate learning that encourages students to be able to regulate cognition by taking into account the situation and tasks assigned. This capability needs to be raised continuously.

Teachers support are needed in the form of the creation of a conducive learning climate which is supported by the learning tools that are designed to raise students' metacognition abilities. Preparation of the learning tools necessary to ensure the implementation of learningas it is expected that students' metacognition abilities can be trained.

The importance of metacognition abilities also have the attention of cognitive psychologists, by suggesting that metacognitive strategies need to be given to students through experiential learning mathematics (Desoete, 2007). For these reasons, teachers are expected to train students' ability of metacognition in learning mathematics, including in problem solving.

Metacognitive learning can bring students to understand the information in learn math, by mastery of facts, concepts and principles. From several studies, it is clear that the application of metacognitionin learning mathematics allows students to master the subject matter well. Mastery of the subject matteris an important factor in the ability of mathematics.

METHODS

This research is the the kind of developmental research, which is carried out to produce a mathematical learning model to train students' metacognition. The resulting

learning model includes syntax, social systems, reaction principles, and support systems. The resulting design learning model will then be tested in the classroom.

The procedures in this study conducted in the development stages of learning model that refers to Plomp (1997) which consists of: (1) the initial investigation phase, (2) design phase, (3) stage of realization/construction, (4) the testing phase, and(5) the implementation phase. Based on the phasing, the learning model presented in this paper is the result of the implementation of stage 1 to3. The development of this learning model currently is entering the testing phase.

RESULTS AND DISCUSSION

The development of mathematical learning model to train students' metacognition today, seems to be quite challenging for the writer. This is mainly due to the relative lack of research his related to metacognition in Indonesia.

These challenges prompted the author stotry to find information that can be used as a handle initial feasibility related learning metacognition strategy. Initialin formation search is done in the form of the initial esearch by involving students. The research was done by creating learning design tools that includes lesson plans, worksheets, teaching materials, and evaluation that focuses on the application of metacognition learning strategies in the classroom.

These preliminary results showed that learning by applying metacognitive strategies more effective in improving student learning out comes when compared to conventional learning. These results are quite encouraging, however, still found some important weaknesses during the learning process. These weaknesses related to there a diness of teachers, a device developed weakness, and the readiness of students.

Based on the results of the initial assessment, realizing the importance of developing a mathematical learning modelas valid, practical and effective way to train the students' metacognition abilities. To optimize the metacognitive exercises conducted, we use the problem-based learning approach and involve contextual math problems.

The result of the design of metacognitive learning model, grouped in four sections: (1) Rational, (2) Supporting Theory, (3) metacognitive learning model, and(4) Model Implementation Guide. Rational development of metacognitive learning model include theoretical and empirical foundation of the importance of the development of mathematical learning model to train students' metacognition. Theoretical foundation examined include various theories supporting the importance of metacognition so that students have the ability mastery of the subject matter. The theoretical foundation is supported by a foundation of empirical research results that have been conducted relating to the importance of metacognition abilities and likely to be practiced to students.

Based on the results of the initial investigation (phase-1), the authors then perform the design model (phase-2). The results obtained in phase-1 and 2 further reflected, discussed with experts, and more scrutiny again. These results then lead tostage-3 is compiling/ more fully realize the metacognitive learning model along with appropriate learning tool sand features necessary instruments.

The products obtained in this phase include (1) Books of metacognitive learning model, (2) learning device according to metacognitive learning model, and (3) the

instrument validity, practicality, and effectiveness of the model. This product as the draft of metacognitive learning model.

Metacognitive learning model applied to the study of mathematics to train students'metacognitive ability is manifested in the form of a book whose contents consist of: (1). Introduction (2). Rational; contains the rationale about importance of developing metacognitive learning model for improving the quality of processes and learning outcomes. (3). The theory supporting metacognitive learning model; includes theories that are relevant for the development of metacognitive learning model. (4). Components of metacognitive learning model; contains parts developed learning model: syntax, social system, the principle of reaction, supporting factors, and the impact of instructional and accompaniment impact. (5). Application strategy of modelin learning

One of the important results that can be presented in this paper is a syntax of metacognitive learning model. The result of this development is through the testing phase in order to obtain appropriate metacognitive learning model, especially formath. The results are presented as follows:

Table1: Syntax of metacognitive learning model.

phase	Activity
Phase-1 Submission of general information	teacher made apperception l, outlines the objectives, presenting the subject matter, and organize students in groups
Phase-2 orientation toward problem solving steps	teacher informs the troubleshooting steps
Phase-3 problem-solving activities with the support of metacognitive question	Teachers guide the students work together in groups to help each other using worksheets. Support is given in the form of metacognitive equestions
Phase-4 problem-solving activities with the guidance of the teacher as needed	Students are directed to cooperate in groups to help each other in solving problems with self-metacognitive raise questions. Teachers only provide assistance in the form of metacognitive questions when students have difficulty
Phase-5 presentation	Students present the results of problem solving work group to receive a response from the other groups.
Phase-6 Evaluations	Students working on individual tasks

CONCLUSION

In accordance with the results that have been obtained, it can be concluded some of the following:

1. Development of mathematical learning to train students' metacognitive capabilities embodied in draft form of valid metacognitive learning model supported by learning tools which are developed specifically to implement the model.

2Modelsproducedafterthe pilot phasewill formametacognitivelearning modelvalid, practice, andefficient.

ADVICE

According the curriculum in 2013 that high school graduates are directed to have the metacognitive ability, so the researchers put forward several suggestions as follows:

1. It should be a teacher orientation activities on metacognition, in needed for teachers to understand and train students to have the metacognitive ability.

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